SANTA CLARA VALLEY WATER DISTRICT

ALAMITOS FISH LADDER
YEAR 2-MONITORING REPORT
2004-2005

Project No. 62742011

Prepared by:

Lisa Porcella
Jason Nishijima

Biologists
Ecological Services Unit
Guadalupe Watershed Division

Under the Direction of:

James Fiedler
Chief Operating Officer
Office of Watershed Operations

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I. PROJECT BACKROUND

As part of the planning process for installation of the Alamitos Fish Ladder, the Santa Clara Valley Water District (District) agreed to a five year monitoring period to ensure that fish passage would be afforded at the new structure. Regulatory constraints imposed in 1997, when steelhead (*Oncorhynchus mykiss*) were federally listed as Threatened under the Endangered Species Act, restricted the direct handling of these fish, and therefore, it was necessary to find a means of passively enumerating fish passage through the new ladder. District fisheries staff determined that a non-invasive fish counting device placed in the fishway would satisfy both the monitoring commitment for the fish ladder and the concerns of the Regulatory Agencies.

In June 2003, after extensively researching the various fish counting devices available, the District purchased a Riverwatcher System (RW) manufactured by Vaki Aquaculture Systems Ltd. in Iceland. The RW was a relatively new product that was promoted as being highly accurate and efficient. At the time of purchase, the District's RW system was only the third unit of its type in use throughout the world. The new RW system was anticipated to provide District staff with invaluable information regarding the timing, abundance, and diversity of fish species utilizing the ladder.

The District maintains an existing Memorandum of Understanding (MOU) with the California Department of Fish and Game (CDFG) for operation of all flashboard dam facilities. The operational timing of the Alamitos fish ladder is mandated in Condition 8 of this MOU which states; "At dams with fish ladders, the fish ladders shall be blocked and water discharge shall be from the bottom of the dam impoundments for the period of June 1 through September 15 of each year." The District and CDFG staff are in the process of trying to amend this MOU so that fish ladders can be operated year-round to facilitate fish passage, however, as of this report, this issue is still unresolved.

II. METHODS

September 15, 2004 marked the start of the second year of operation for the RW system in the Alamitos Fish Ladder. Installation and functionality of the RW did not change from the previous year's operation.

In 2003, District staff designed and manufactured a housing which enabled the counting device to fit directly into one of the existing fish ladder panels (Figure 1). The counter itself is a rectangular shaped unit which is completely submerged within one of the pools in the fish ladder. Fish are directed through the counter opening which is lined with infrared light emitting diodes. When a fish swims through the counter and breaks the plane of light beams, the fish is scanned and a resulting silhouette image is sent to the on-site computer (Figure 2). Other information recorded as the fish passes includes: the speed the fish was traveling, the direction the fish was moving (upstream vs. downstream), the body depth of the passing fish (for depth to length ratios), along with the date and time. Fish moving in the upstream direction trigger an underwater black and white video camera which takes up to 5 digital photos of each fish. This enables the user to scan through the images to confirm the presence of a fish and potentially identify the species. All of the data collected by the RW is stored by the attached on-site computer which is powered by six deep cycle 6-Volt batteries that are continually recharged by two 165 watt solar panels.

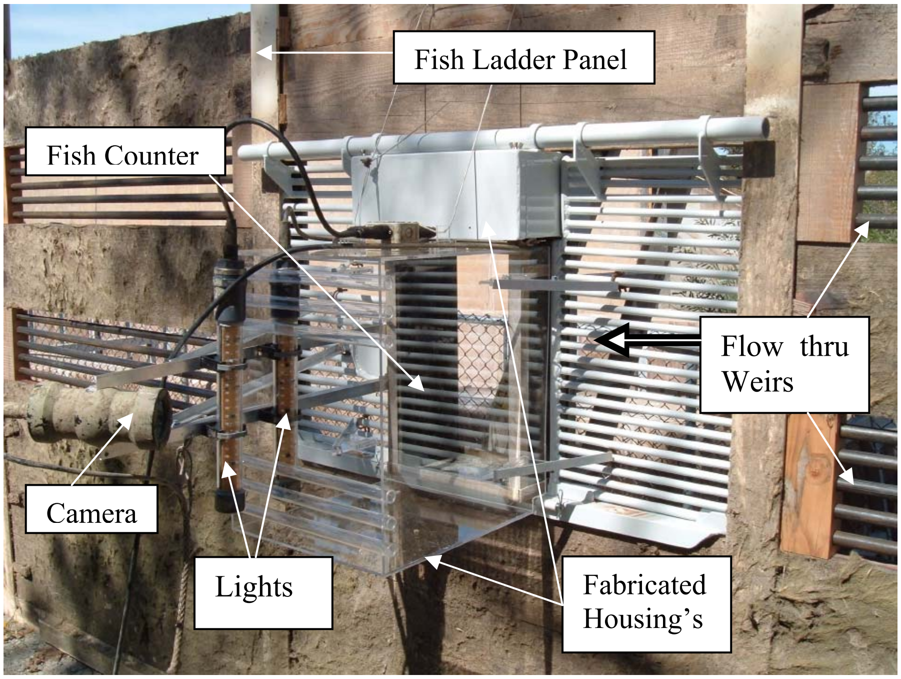

Figure 1. RW fish counter with specialized modifications.

The counter was maintained daily during the storm season (November – February) and bi-weekly thereafter until the ladder was decommissioned for the season on June 1, 2005. Typical maintenance included clearing debris build up from the counter, downloading data from the database, and resetting the system. Similar to year one operations, the RW system had some problems which required modifications throughout the year. These issues are detailed in the Results section below.

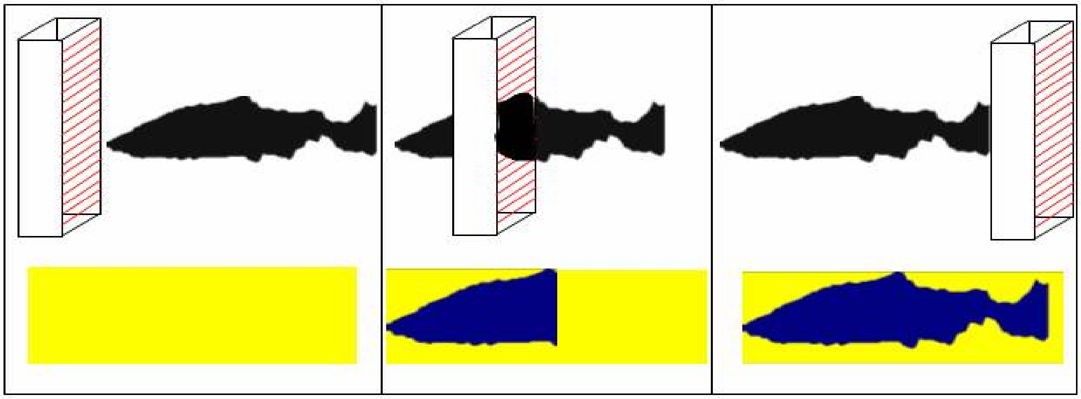

Figure 2. Representation of RW scanner function and the resulting silhouette.

On June 1, 2005, when the Alamitos ladder was decommissioned for the season per the CDFG MOU, District fisheries staff observed steelhead/rainbow trout stranded in the fishway. After discussing the situation with Kent Aue of the CDFG staff, it was determined that the most prudent course of action was to restore a small amount of flow to the fishway to enable stranded fish to move downstream. District water operations staff divided the release flows so that 60% would be released through the outlet structure at the base of the dam and 40% would flow through the fishway. District fisheries staff monitored the situation and saw no further signs of fish stranding in the ladder.

While the flow regime was modified, District staff took the opportunity to deploy automated temperature loggers at the base of the fish ladder and at the base of the drop structure to discern whether temperatures differed between the two locations. Staff also took bi-monthly temperature profiles within the dam impoundment at the entrance to the fishway and the entrance to the outlet structure to compare temperatures at the two locations and determine if there was any thermal stratification within the impounded water.

III. RESULTS

September 2004 – June 2005

From September 15, 2004 through June 1, 2005, over 1000 aquatic animals of various sizes, shapes and species utilized the ladder and moved through the RW device. The variety of species using the ladder appeared to be the same as the 2003-04 season and included: salmonids (*Oncorhynchus* spp.), common carp (*Cyprinus carpio*), largemouth bass (*Micropterus salmoides*), Sacramento suckers (*Catostomus occidentalis*), red-eared sliders (*Pseudemys scripta*), western pond turtles (*Clemmys marmorata*), bullfrogs (*Rana catesbeiana*), and various duck species. Fish species utilized the ladder for passage in both directions, while the turtle, frog, and duck species used the fishway exclusively for downstream passage.

As was problematic in 2003-04, most of the photographs produced by the RW system were not clear enough for District staff to differentiate between fall-run Chinook salmon (*O. tshawytscha*) and steelhead/rainbow trout. Therefore, both species were lumped together and designated as ‘salmonids.’ District fisheries staff confirmed the presence of salmonids by analyzing the silhouette and size data produced by the RW, along with the limited photographic information (Figure 3). From this analysis, District staff concluded that a total of 28 salmonids moved upstream through the RW, and subsequently 12 traveled back downstream through the RW. It is likely that these numbers are slightly low since fish may have moved upstream or downstream during the periods when the counter was non-functional. Additionally, a salmonid ‘hit’ was not considered valid and was not counted if the fish moved upstream and then immediately back downstream.

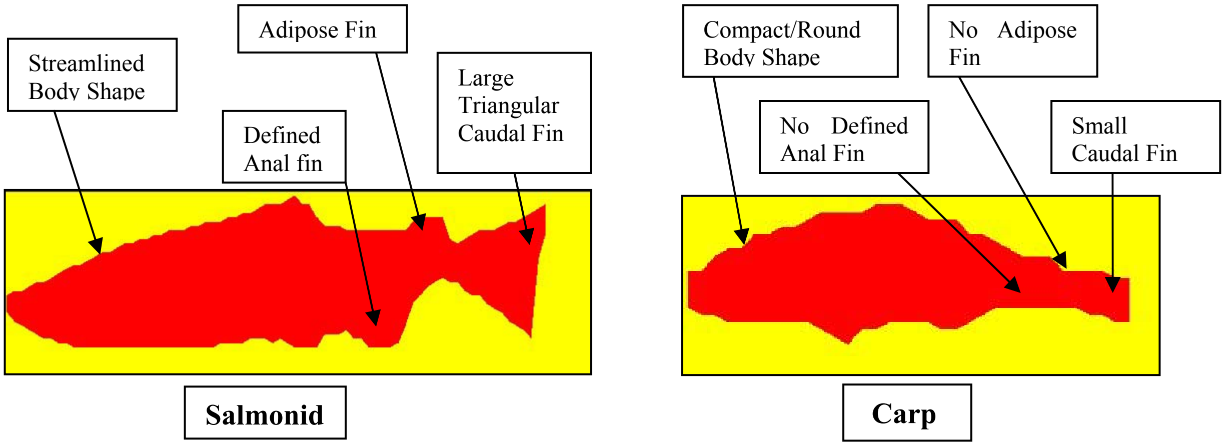

Figure 3. RW Salmonid silhouette vs. Carp silhouette.

Similar to the previous season, the migration of salmonids to the upper watershed appeared to be triggered by the first large storm event of the year. Migration of salmonids through the RW (both upstream and downstream) occurred from October 20, 2004 through March 20, 2005 (Figure 4). During that time period, both Chinook salmon and steelhead/rainbow trout were positively identified above the ladder by District fisheries staff. An adult steelhead/ rainbow trout was found on Alamitos Creek at Graystone Lane on January 31, 2005. A Chinook redd and subsequent carcass was identified on Alamitos Creek approximately 1 mile upstream of Almaden Lake on December 14, 2004 and February 7, 2005, respectively.

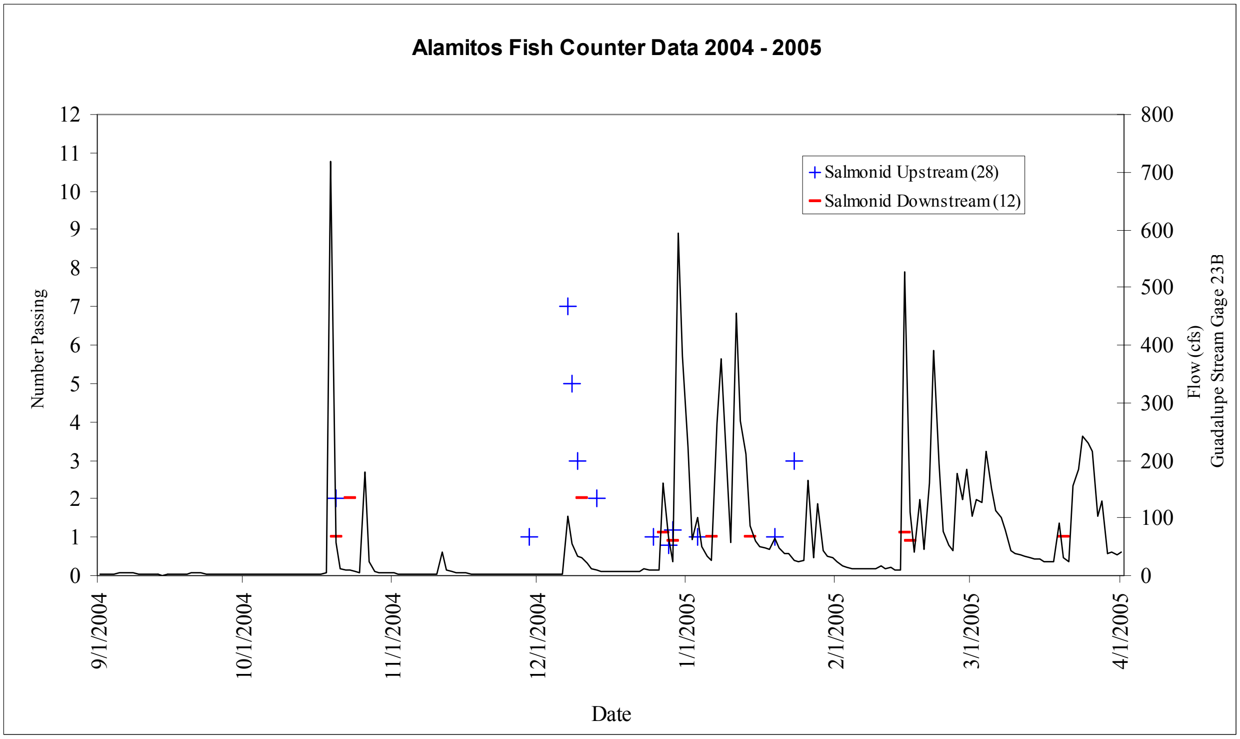

Figure 4. Salmonid passage at the RW vs. date and flow.

Unfortunately turbidity and poor camera resolution continue to limit photographic species identification to atypical occurrences of good water clarity. In November and December 2004 four Chinook salmon were positively identified when they swam in close proximity to the camera displaying their characteristic irregular shaped dorsal spots and prominent head shape (Figure 5).

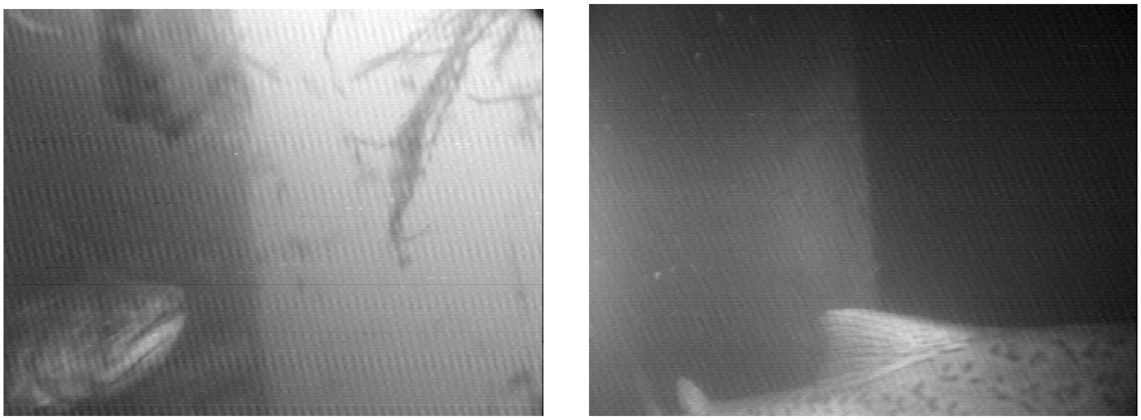

Figure 5. Chinook photos from the RW.

To date District staff has not been able to identify steelhead usage of the fishway based solely on the RW's photographic data. However, based on seasonal timing and estimated fish length, four up-migrant salmonid silhouettes recorded by the RW in late January 2005, are likely to have been steelhead. These fish traversed the fishway from January 19-23, 2005 and ranged in size from 42-74 cm in length. Subsequently, the final 3 salmonid silhouettes recorded by the RW for the season in February and March were all downstream migrants of similar size to those which traversed the ladder one month prior. The timing of this out-migration was synchronized with rain events that elevated flows.

Other migratory patterns detected by the RW include those of the common carp and the largemouth bass. When the fishway opened for the season on September 15, 2004, six largemouth bass that were apparently rearing in the decommissioned ladder, traversed their way down the fishway, while 47 carp traversed up the fish ladder (Figure 6). Similar to the 2003-2004 data, common carp were once again the most prevalent users of the fishway, with at least 20 carp moving through the RW on a monthly basis.

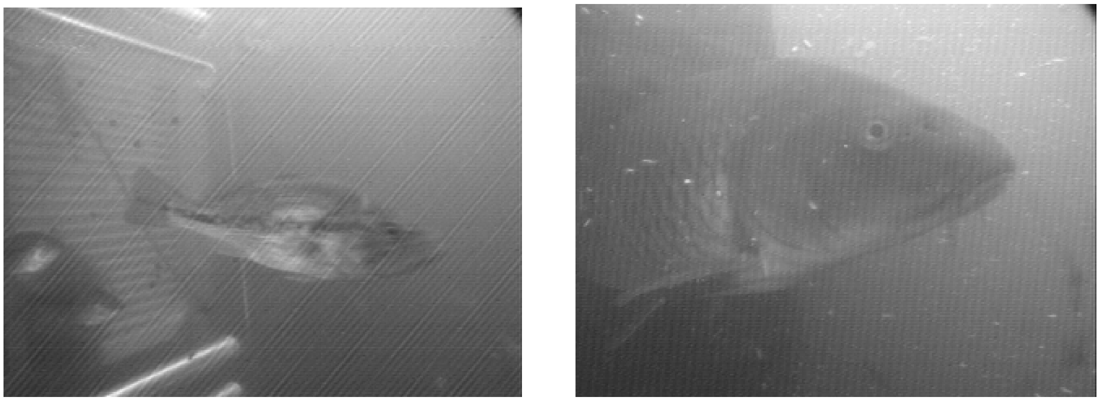

Figure 6. RW photos of largemouth bass and common carp in the fishway.

Temperature trends were similar to the 2003-04 fish counter season. Temperature data in the fish ladder was automatically collected every three hours by the RW (Figure 7). Temperatures ranged from 19-24°C from mid-September through mid-October. Temperatures then dropped to 14-18°C through mid-November and then again to 10-13°C through mid-February. From that point on temperatures began to increase to 12-15°C in early March and 14-17°C for the later part of the month. There was a drop in temperature to 12-16°C for the first 2 weeks in April and then a steady increase from 14-18°C by the end of April. Temperatures in May and June reached well over 20°C. During the period of salmonid migration through the RW (October – March), temperatures ranged between 10-18°C.

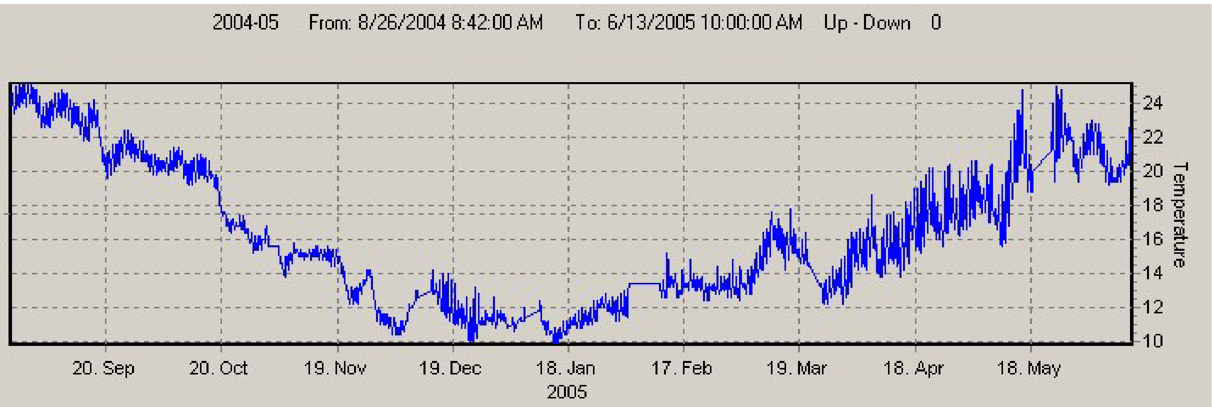

Figure 7. Fishway temperature data during operation of the RW.

Water temperature data collected after the RW was removed for the season and release flows were modified, showed on average a 0.5°C difference between temperatures at the base of the fish ladder and those at the base of the drop structure dissipation pool. Daily water temperature fluctuations varied in the two locations; on average there was a 1.7 degree fluctuation of water temperatures in the fish ladder while the dissipation pool at the base of the drop structure fluctuated 3.5 degrees per day. In addition, average daily maximum temperatures were 1°C higher in the drop structure plunge pool than in the fish ladder.

Unfortunately, in mid-August, water levels at the base of the drop structure receded and exposed the temperature logger which began recording air temperatures instead of water temperatures. Therefore, no comparison of water temperatures at the base of these two structures can be inferred from mid-August through September. During this period, however, temperature profile data was collected manually at the top of the drop structure to detect any possible thermal stratification within the dam impoundment.

All temperature profiles were conducted in the late afternoon hours to show the 'worst case' scenario (i.e., maximum solar heat transfer to surface waters) with regard to surface versus bottom temperatures. No major temperature differences (i.e., no more than 1°C difference) were detected between the fish ladder inlet and the dam outlet structure. In addition, only minimal temperature stratification was found within the dam impoundment (Figure 8). Stratification ranged from 0.2°C in early July to 3.3°C in late August. However, on average stratification was 1.5°C.

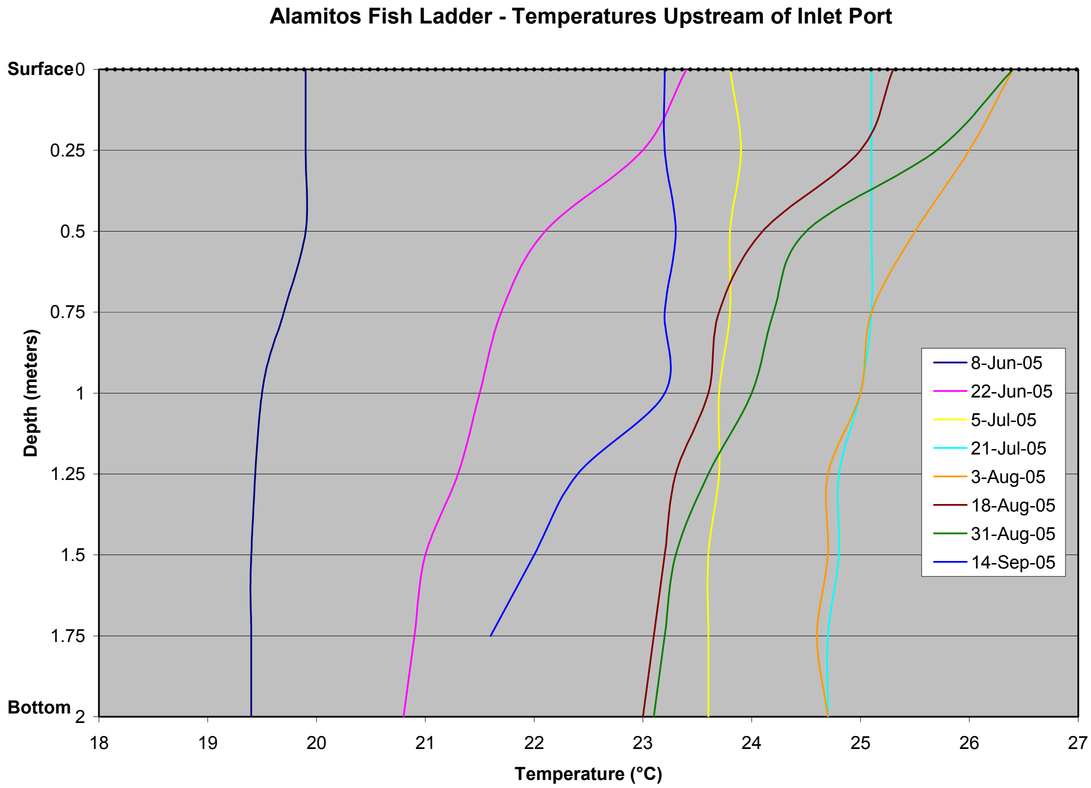

Figure 8. Alamitos dam impoundment temperature profile data during the ladder off season.

Problems Encountered and Modifications Made

The second season of operation saw similar RW malfunctions and errors as year one's operation. The RW was installed for a total of 260 days and was not fully functional for 60 of the days during that period. Several times the counter malfunctioned, had software problems, or required modifications.

From September 15 through November 29, 2004 the RW had 13 failures, accounting for 44% of the records collected in the period. During that time, the RW's "Maricam" software program faltered when too many error codes overloaded the system in a short period of time. A software error ensued in which passage events were documented but neither a silhouette nor a speed was recorded. Because the camera portion of the RW system worked so poorly due to limited water clarity in the Guadalupe River, this software error rendered the system effectively non-functional during these periods. In 2003, the manufacturer determined that this type of software error was caused by excessive debris, turbulence, and increased flows. In summer of 2004, District staff installed a modified debris boom at the entrance to the fish ladder to minimize submerged debris entering the ladder. However in late 2004, the software error was still a common occurrence.

In December 2004, the manufacturer offered to upgrade the hardware and software on the RW unit in an attempt to alleviate the software errors. After borrowing a RW unit without photo capability in January 2005, District staff sent the RW computer and camera unit to Vaki in Iceland for computer upgrades and a new wide angle lens for the camera. In March 2005, the newly upgraded unit arrived and was re-installed in the fishway. The manufacturer's upgrades substantially reduced the number of software errors.

During the winter storms in mid-December 2004, the RW system shut down when the power source failed. As was the case in the 2003 season, the source of the problem was assumed to be due to low light and overcast weather conditions during which the solar panels were unable to recharge the four batteries which run the computer. Two more batteries were added to the power load bringing the total to 6 batteries. However, this did not fully solve the problem. In early January 2005, another series of storms triggered a RW power failure. District staff decided to replace the original solar panels (110 watts each) which were slightly cracked due to summer vandalism, with higher capacity ones (165 watts each). The new solar panels were covered with a sheet of clear polycarbonate (1/8″ thick) to deter vandalism. No RW power failures have occurred since these upgrades were installed.

Water clarity was again quite problematic in the fish ladder. Algal blooms, turbidity, and clumps of vegetation created problems for acquiring clear photos of fish. The camera angle, its distance from the counter, insufficient camera light sources, reflective backgrounds, and camera quality were all issues throughout the year. The camera resolution (640 dpi x 480 dpi) was also relatively poor quality when compared to current standards. When enlarged for fish identification purposes, the pixels enlarge and the image disintegrates. Unfortunately, the new wide angle camera lens has not noticeably improved the photographs taken by the RW. In fact, District staff hypothesizes that the current light sources are insufficient at night to illuminate the extent of the new wide angle lens and therefore, night-time photo capability has been significantly reduced.

A final modification made to the fishway included adding an escape platform for wildlife that were unable to locate the underwater opening of the fish counter (Figure 9).

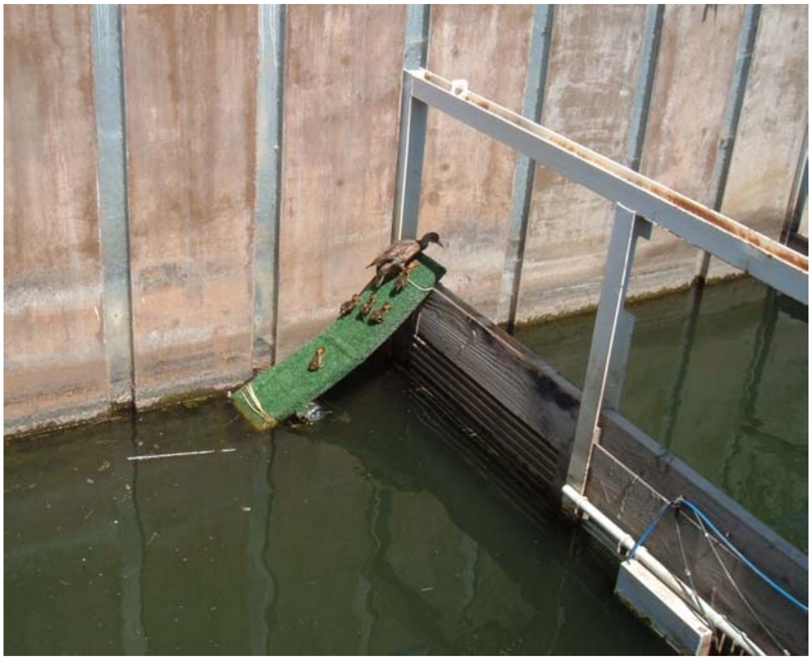

Figure 9. Escape platform for wildlife unable to locate fish counter opening.

IV. DISCUSSION

Similar to the first year of operation, the fish counter had some difficulties to overcome during its second season. Additional batteries, new solar panels, software and hardware upgrades, new upstream debris booms, and a wide angle camera lens were among the many improvements made to the RW system in the second season.

Although modifications were required, the RW was still quite functional and documented over 1000 passage events in the fish ladder, recording a variety of species. Similar to the 2003/04 season, upstream migration of over 20 adult salmonids through the fishway began just after the first large storm event for the year. Based on seasonal timing and additional field observations, staff speculates that the RW captured silhouettes of four adult steelhead up-migrating in late January and three adult steelhead out-migrating in February and March.

Unfortunately, turbidity and camera problems continue to limit photographic species identification to atypical occurrences of good water clarity. However, the 2004/05 RW season captured superior photographic images to the 2003/04 season, suggesting that the on-going modifications to the fish counter are enhancing its functionality.

In June through September 2004, while the ladder was decommissioned per the CDFG MOU agreement, largemouth bass were seen rearing in the pools of the fishway. This past summer however, while the fish ladder was partially functional from June through September 2005, no largemouth bass were observed in the fishway. It is likely that maintaining a small volume of flow through the ladder prohibited or deterred the bass from utilizing the fishway as rearing habitat.

In addition, when the ladder operations were modified in June 2005, approximately a dozen juvenile steelhead/rainbow trout were observed stranded in the pools of the fishway. It is possible that these fish were resting and/or rearing in the fishway at that time. Hence, maintaining flow through the fishway during the summer season may be more beneficial to native than non-native fish.

Temperature stratification in the dam impoundment from June through September appears to be minimal (average of 1.5°C) based on this seasons data. Additionally, temperatures at the base of the drop structure had much larger daily fluctuations than those at the base of the fishway (3.5°C vs. 1.7 °C). Based on the potential for native fish usage and minimal temperature differentiation observed within the dam impoundment, District fisheries staff suggests that the Alamitos fishway be kept open and functional year-round. District staff would like to resume discussions with CDFG staff to modify the existing MOU to incorporate these operational changes.

District fisheries staff has considered relocating the fish counter further upstream next season to the Masson fish ladder in Guadalupe Creek. Staff believes that the conditions at this ladder will be better suited for the photographic portion of the RW. Additionally, no quantitative fisheries data has ever been collected at the Masson ladder with respect to its ability to pass fish. Since the Masson ladder is upstream of the Alamitos ladder, data collected at Masson will provide ancillary information about fish passage downstream.